REMARKS

Receipt of the Office Action of June 4, 2008 is gratefully acknowledged.

The drawing is objected to because numeral 23 is shown in Fig. 3 but not mentioned in the specification. In reply, the specification has been amended to include a reference to numeral 23. A corrected drawing sheet is therefore not required.

The title of the invention is objected to. In reply, an amended title has been inserted into the application by an amendment to the specification. This title has been suggested by the examiner.

Claims 16 and 25 are objected to on formal grounds. Claims 16 has been combined with claim 14 and the combination includes a proper antecedent basis for the plane of symmetry recitation. Claim 25 has also been amended to provide a proper antecedent basis for "said element" as "said roof element."

The rejection of claims 25 and 26 under 35 USC 112, first paragraph is noted and respectfully traversed.

It is respectfully submitted that the "roof elements" of claim 25 are shown so long as one is shown; and one is shown. A roof element of different thickness would not look differently, except that it would have a different thickness. This condition of the roof element should be readily understood by one of ordinary skill in the art. As to density, how is one to shown density? It is sufficient to note that different densities are contemplated. That should be sufficient.

As to claim 26, the examiner states "[i]n what manner would the two be combined together?" In any manner. Such a conclusion would immediately occur to one of ordinary skill in the art.

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The rejection of claims 14 - 18 and 24 under 35 USC 102(b) by Klass et al is noted and respectfully traversed.

Klass et al does not teach a ring-shaped membrane, or diaphragm, provided in the region of a node plane or the plane of symmetry of an oscillatable unit, via which membrane, or diaphragm, the oscillatable unit is connected with

the housing. Klass et al discloses an ultrasonic transducer for use in a flowmeter for a fluid; the sensor including a housing 3, a piezoelectric disc 2, two electrodes 6 and 7 and two terminal electrodes 8 and 9 (Fig. 1). The membrane, or diaphragm, also numbered 8, as shown in Figs. 3, 5, 7 and 9, is cup-shaped with a revolving rim 27, as the "automated process" translation from the European Patent Office shows: "The diaphragm 8 against it supports itself in a channel 24 of the converter chamber 3 off (see figs 5 and 7). In particular a rim 27 is provided, in the channel 24 in-lies at the diaphragm 8". See paragraph [0068] of the translation, (a copy of the translation is attached). But, as is now recited in amended claim 14 (originally found in claim 16), the ring-shaped diaphragm is provided in the region of the node plane, and the oscillatable unit is connected to the housing by the diaphragm. Hence, at least this feature is not taught by Klass et al.

The examiner states, that Klass et al (particularly in Fig. 9) discloses the oscillate membrane being symmetric about the imaginary node plane, "wherein the imaginary node plane dissects the piezoelectric element in half and the ring-shaped membrane, 19, connects the oscillatable unit to the housing and lies in the plane of symmetry". But the piezoelectric disc is fixed by the membrane, or diaphragm, 8, as the automatic translation of paragraph [0079] from the European Patent Office shows: "In Fig. 9 a part of a flowmeter is shown, with which likewise two ultrasonic transducers are arranged next to each other. Each ultrasonic transducer 1 exhibits thereby a separate converter chamber 3 as well as a diaphragm 8 in each case. The diaphragm 8 is fixed in each case to a piezoelectric disc 2. The sound path runs transverse to the water path. So that a taking along effect occurs, the sound must become by means of mirrors diverted. The mirrors for sound detour did not become however shown".

The reference symbol 19 is referencing a seal without a function to fix the piezoelectric disc to the housing as the automatic translation of paragraph [0075] from the European Patent Office discloses: "In the corner area between bar 11

and adjacent surface 13 of the converter chamber 3 is an O ring 19 provided, which provides for a seal of the diaphragm 8".

An object of the present invention is to provide an ultrasonic flow measuring device in which the portion of the ultrasonic measuring signals which propagates via the wall of the pipeline is minimized. The object is achieved according to the invention among other features by the feature of claim 14: "at least a portion of the external surface of the oscillatable unit is connected with the housing in the region of the node plane" and the amended features of claims 15 and 16. The ultrasonic transducer disclosed by Klaas is not constructed in a symmetric manner. The piezoelectric disc 2 with the electrodes 6, 7 and the terminal electrode 9 contacts the housing 3 directly and the cup-shaped diaphragm 8 fixes this "oscillatable unit" to the housing 3. Hence, there is no sound decoupling between the oscillatable unit of the ultrasonic sensor and the environment, as disclosed in the paragraphs.

In view of the foregoing, reconsideration and re-examination are respectfully requested and claims 14 and 17 - 26 now found allowable.

Respectfully submitted,
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[0001] The instant invention concerns an ultrasonic transducer, in particular for the use in a flowmeter for liquid or gaseous medium with the other features of the preamble of the claim 1 as well as the claim 21. The invention relates to in addition a flowmeter for liquid or gaseous medium with at least an ultrasonic transducer according to the present invention.

[0002] Ultrasonic transducers, which are designed for the use in a flowmeter for liquid or gaseous medium in particular, exhibit at least a piezoelectric body, in particular a piezoelectric disc, which is in a topfförmigen converter chamber arranged and is at of them the Mediums directed front side a first electrode as well as at their back a second electrode arranged. Furthermore the first electrode is with a first terminal electrode (so called diaphragm) and the second electrode with a second terminal electrode to the power supply contacted.

[0003] An ultrasonic transducer of the described type is 29 34 031 known from DE, with which the piezoelectric disc on a shoulder of the topfförmigen converter chamber in radial direction rests upon more movable, is reserved from the converter chamber at its outer surface and by means of a resilient seal both against the converter chamber sealed and elastic held is. At front and back of the piezoelectric disc a laminar electrode is arranged. The first as well as second terminal electrodes are formed as lead wires, which are connected with an end with a power cable penetrating the housing bottom and with their other end with an electrode in each case. The wires intersperse thereby the ultrasonic-insulative space between the back of the piezoelectric disc and the housing bottom. The disadvantage of this ultrasonic transducer consists of the fact that the wiring requires a larger structure of the entire ultrasonic transducer. The assembly of a such ultrasonic transducer cannot become automated performed. In addition the lead wires fixed at in each case a particular point of the electrode lead solder-measure-dependent damping to geometry and the piezoelectric disc.

[0004] With from EP 0,897,101 known ultrasonic transducer is its electrodes likewise with lead wires connected, which are outward guided by an opening of the housing. On the housing a diaphragm is welded on, which holds the piezoelectric disc bottom tensile stress and against a plastic part inserted in the housing presses axial. The entire assembly of the ultrasonic transducer proves and. A. by welding on the diaphragm as well as the additional inserted plastic part as extremely expensive and therefore cost-intensively.

[0005] Also the sound sensor known from EP 0,679,874 shows a relative bulky structure, with which centered-hurry within a topfförmigen housing portion provided is, in order to stabilize the piezokeramische disc in their layer. An additional presser member presses the piezoelectric disc due to a contact pressure over a contact foil on the bottom. In addition the presser member exhibits a central located, stiftförmigen extension, whose end serves an electrical lead for the terminal.

[0006] The instant invention is the basis the object to create a simple mountable ultrasonic transducer which is simple constructed and whose piezoelectric body experiences an only small radial damping.

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[0007] This object becomes 1 dissolved by the characterizing features of the claim. Favourable developments of the invention result from the Unteransprüchen 2 - 20.

[0008] A favourable ultrasonic transducer becomes also 21 taught in claim. A flowmeter according to invention comes out from claim 23.

[0009] The ultrasonic transducer according to invention is in such a manner constructed that the first terminal electrode is provided as diaphragm formed, is additional to the converter chamber and the diaphragm locks the converter chamber at the side of the piezoelectric disc. The piezoelectric disc is radial movable thereby, D. h. without radial damping at the converter chamber positioned. The piezoelectric body becomes fixed of the diaphragm in its position. The ultrasonic transducer is therefore extremely compact constructed with only few components and is characterised by small offset and an high degree of automation. If the independent devices finished are present, the ultrasonic transducer can become fully automatic mounted.

[0010] The first and second electrodes arranged at the piezoelectric disc, which serve the piezoelectric disc for the polarized one and for contacting, can be with the associated in each case terminal electrodes also integral formed.

[0011] In a possible execution variant the converter chamber can be topfförmig with open side formed, whereby the diaphragm locks the open side of the converter chamber. With the fact is ensured that the piezoelectric disc is further radial movable.

[0012] In an other execution variant the piezoelectric disc can be also at the converter chamber arranged and becomes thereby by the diaphragm at the converter chamber held.

[0013] The diaphragm cannot stand more immediate with the Mediums in contact and it is other components to their protection or such necessary.

[0014] The piezoelectric disc can be a thick resonance oscillator. It is necessary to give to the swinging member radial clearance in order not to dampen the Materialverdrängung due to the thick oscillations.

[0015] The diaphragm can be with particular advantage topfförmig formed, whereby this topfförmige diaphragm and the topfförmige converter chamber with their open sides are against each other in such a manner joinable that a receptacle for the piezoelectric disc becomes formed. The pot form a possible particularly assembly-friendly and automizable manufacture. The topfförmige diaphragm as well as the topfförmige converter chamber are preferably in stable manner so joinable that the Piezoscheibe is safe positioned between them. In addition, with the other execution variant, is arranged with which the piezoelectric disc at the converter chamber, is the topfförmige diaphragm of advantage. The piezoelectric disc becomes held thereby of the topfförmigen diaphragm at the converter chamber. Also this execution variant is assembly friendly and a possible automizable manufacture.

[0016] The diaphragm can exhibit a rim, in the housing and/or. at a side wall of the converter chamber in-lies. Thus a particularly safe fixation of the diaphragm becomes possible.

[0017] The piezoelectric disc can rest upon thus a in particular managing support of the converter chamber and is thus in axial direction in its layer secured, whereby free rockers due to the diaphragm arranged on the front side possible is. Simultaneous one rests upon the piezoelectric disc, also as Piezo Dickenschwinger referred, radial movable on the managing support of the converter chamber. The Piezoscheibe is therefore reserved with the topfförmigen converter chamber lateral from it. The managing support knows z. B. annular or also full-laminar formed its.

[0018] In particular the support can be an integral part of the converter chamber. Thus can become the compactness, the stability as well as the assembly friendliness of the ultrasonic transducer substantially increased.

[0019] The topfförmige diaphragm can exhibit a peripheral edge, which rests against the converter chamber, in particular a circumferential bar of the converter chamber (in particular from the outside). By means of this construction a simple assembly can take place from diaphragm and converter chamber, whereby a simultaneous safe connection of the two components is ensured.

[0020] Furthermore the diaphragm can exhibit a peripheral edge, which runs to a circumferential bar or to the converter chamber bottom formation of a gap. This leads to a decoupling of diaphragm and converter chamber with the advantage that the respective components have a thermal expansion possibility.

[0021] The circumferential bar is reserved to the piezoelectric disc, so that the piezoelectric disc can swing radial free. In addition thereby place provided becomes, the z for a sticking burr. B. by an eventual adhesive bond between converter chambers and terminal electrode and/or. Terminal electrode and electrode develop, without the sticking burr the radial vibration of the Piezoscheibe obstructed. The sticking burr obstructed thereby also not the axial receptacle of the piezoelectric disc.

[0022] The first electrode and/or the second electrode rest upon favourable-prove laminar, in particular full-laminar the piezoelectric disc. An optimum and removal on the piezoelectric disc become achieved thereby.

[0023] Favourable way the contacted first diaphragm the first electrode and/or the second terminal electrode also the second electrode essentially full-laminar, with which the piezoelectric disc is to a safe between the terminal electrodes fixed. To the other made by the full surface contact of the terminal electrodes with the electrodes an optimum signal transmission.

[0024] Furthermore the effected full surface contact of the terminal electrodes a suppression and thus an avoidance of parasitic resonances, which lead to periodical modes of motion. The diameter of the respective terminal electrode can favourable-proves at least as large as being as the diameter of the swinging element (piezoelectric disc) and/or. like the diameter of the associated in each case electrode. By the terminal electrodes parasitic radial oscillations become suppressed. In addition the active area and thus the signal energy become enlarged by the flat-moderate larger terminal electrodes opposite the electrodes. The sequence is and. A. that an individual frequency setting does not have to become any longer prescribed.

[0025] Over a good fixation and/or. Positioning of the piezoelectric disc and optimum signal transmission to reach, knows the second terminal electrode with the piezoelectric disc and/or. the second electrode bonded arranged on it its.

[0026] Just as also the other side of the piezoelectric disc can and/or. the first electrode with the diaphragm z. B. by means of an hard, highly liquid adhesive bonded its, in order to ensure also on that to the Mediums of facing side an optimum signal transmission and also positioning of the piezoelectric disc. The smallest offset drift becomes achieved, if the adhesive bond and the flat edition have forwards and the rear piezoelectric disc comparable acoustic properties.

[0027] It can be also the second terminal electrode with the support bonded.

[0028] Furthermore in particular its support, a double sided adhesive tape provided between the second terminal electrode and the converter chamber, can be which both when and and reliable acoustic bridge for the converter chamber serves assembly aids. The adhesive tape can exhibit for instance a starch from in particular 0.01 mm to 0.1 mm and be for the guarantee of a constant swinging behavior of the piezoelectric disc permanent elastic formed. As the adhesive tape at each location exhibits the same starch, ensured it also at each location a constant gap between the support and the terminal electrode, which leads again to an optimum measuring behavior.

[0029] An other possibility consists of the fact that the peripheral edge of the diaphragm positive intervenes in the circumferential bar of the converter chamber or encloses the circumferential bar positive.

[0030] The converter chamber, in particular the bar or a circumferential surface attacking to the bar can exhibit partial recesses to the attachment of the diaphragm. Into these partial recesses the diaphragm knows positive engage by means of a rest connection. The converter chamber, in particular the bar or the circumferential surface attacking to the bar, can exhibit also a circumferential groove to the attachment of the diaphragm. The diaphragm knows thereby likewise into the circumferential groove positive engage (z. B. by means of a rest connection), with which the diaphragm is safe fixed at the converter chamber. With these connections natural can be an additional adhesive layer between diaphragm and converter chamber to the safe seal provided.

[0031] The first and/or second terminal electrode can do at least in each case one upward toward an electrical terminal distant tab (z. B. Solder tail) exhibit. The tabs form contact tongues for the connection with a current conductor (z. B. Cable, printed circuit board, contact spring etc.). The tab z. B. the second terminal electrode can as loop be shifted, in order to hold the thermal forces, which affect the swinging member, small and constant. For this purpose the tab can be also in the bending radius tapered or perforated. The tabs of the first and/or second terminal electrodes can step by openings of the converter chamber outward. These openings can be with adhesive sealed, in order to become without strain and water-sealed. Furthermore the mentioned above loop can be with the converter chamber bonded, in order to dampen the tab and to make so the measurement error smaller.

[0032] The tabs can be without strain also on other manner at the converter chamber arranged, by itself z. B. the tab of the second terminal electrode against a projection or a stage of the converter chamber supports. The diaphragm and/or. a rim arranged to it can in-lie in a channel of the converter chamber.

[0033] According to invention the piezoelectric disc without bias on the support can rest upon. Thus a free vibration becomes possible with the sequence of a smallest measurement error as well as a smallest distortion of the offset stability.

[0034] The managing support of the converter chamber specified above knows z. B. annular its, from partial bars or pins exist to be also full laminar or (see below) formed. The space formed by the managing support and the diaphragm ultrasonic-insulative formed can be, by he z. B. with air filled is. The space can be therefore sound-reflective or sound-absorbing designed. As also an ultrasonic-insulative material can as z in the space. B. an elastomer or a plastic foam provided its. With this ultrasonic-insulative space a constant bridge or Schallisolation between the converter chamber and the piezoelectric disc, uninfluenced by temperature and pressure, is to become ensured. Therefore so a flat-conductive material can be provided also in the space between the managing support and the piezoelectric disc. It is z. B. possible, first a flat-conductive material z. B. Ryton with subsequent sound-reflective material z. B. To plan air or metal.

[0035] The piezoelectric disc is appropriately from the bar of the converter chamber and/or. the edge of the diaphragm spaced, so that the Materialverdrängung is not absorbed due to the thick oscillation.

[0036] With particular advantage the converter chamber a part of the flowmeter, z can. B. a vortex chamber or a sensor housing its. The assembly of the remaining components can take place thereby in simple manner. By the integration of the carrier into a part of a group of connections of the Durchflusszählers an other seal can be void.

[0037] The second terminal electrode, which is arranged at the back of the piezoelectric disc, can be also by a metallic coating of the support formed. This the facilitated entire assembly of the ultrasonic transducer still more other.

[0038] The support and/or. the converter chamber can consist of plastic, in particular of a thermoplastic. In particular the support can and/or. the converter chamber of PVDF (polyvinyl chloride) consist.

[0039] The converter chamber including the support, in particular if these full-laminar formed is, can from an ultrasonic-absorptive material, z. B. Rubber, thermoplastic such as EPDM or PVDF (polyvinylidene fluoride) exists. With particular advantage the impedance of the material of the converter chamber can and/or. it is appropriate for the support in the range of the impedance of the Mediums which can be measured with which the smallest offset drift achieved becomes. Forwards and the rear piezoelectric disc are therefore present the same conditions regarding the impedance. Favourable way knows therefore the impedance of the converter chamber and/or. the support approx. (1.5 + 0.3). 10< 6> kg/m< 2> s, in particular 1,5. 10< 6> kg/m< 2> s amount to, if it concerns with the Mediums which can be measured waters. The advantage from PVDF is that its glass transition temperature lies outside of the measurement range. In addition PVDF has the advantage that the parameters such as z. B. Dense ones, sound velocity, wavelength and impedance of the similar corresponding parameters from water are. Thus an optimum linking into the PVDF material becomes ensured as in waters. The thickness of the support (so called absorber-high) can amount to in particular 3.55 mm.

[0040] As already mentions, the piezoelectric disc on its whole surface on a corresponding designed managing support can rest upon. The advantages for this become other down still more near explained. The converter chamber can be sound-absorbing thereby more or less sound-permeable or depending upon execution variant and exhibit no free space.

[0041] At the converter chamber favourable-proves a plug-on mass can for mass inhibition provided to be. But a receptacle provided, becomes used into which the plug-on mass, those can be effected together with a sound-permeable converter chamber an impedance jump (rear wall reflection) at the converter chamber.

[0042] With advantage the first and/or second electrode can be sputtered on the piezoelectric disc vapor deposited or baked subsequent applied by means of screen printing methods and or. The electrodes do not have to become therefore with the assembly separate into the ultrasonic transducer used. The vapor deposition, printings or sputtering of the electrodes effected in addition a safe and durable connection with the piezoelectric disc. Z know the first and/or second electrode. B. of Ag, CrNi or an alloy with one of these metals consist.

[0043] The diameter of the piezoelectric disc can favourable-proves at the most 7.5 mm to amount to. This small size can be by the small dimensions in a vortex chamber as measuring chamber conditional. Favourable way can be 3.8 times larger the diameter of the piezoelectric disc 3.3 to as their thickness. Since the resonant frequency of a thick oscillator predominant depends this thickness with the resonant frequency z on its thickness (smaller thickness means larger frequency and reverse), knows. B. a target of 1 MHZ in accordance brought become. Recapitulatory it is to be stated that the ratio from diameter to thickness of the piezoelectric disc is in the ultrasonic transducer according to invention a relative small. An other advantage thereby is that with removing diameter of the disc their compressive strength increases.

[0044] At least one of the electrodes can be glued on also the front and/or back of the piezoelectric disc, whereby the Nebenresonanzen becomes suppressed by this glued on electrode (n).

[0045] The piezoelectric disc and the diaphragm and/or. the piezoelectric disc and the second terminal electrode can favourable-prove from the same material executed to become, in order to avoid a Spannungskorrision.

Likewise can consist the respective electrodes and/or the electrode and the associated in each case terminal electrode of the same material. The material of the electrodes and/or the terminal electrodes can be thereby from corrosion and/or erosion-stable material. In particular it is object of the diaphragm to protect the swinging member long-term-stable from waters.

[0046] The diaphragm can cause long-term and temperature-stable fixation of the piezoelectric body.

[0047] In particular the diaphragm, in addition, the second terminal electrode can from a deep-drawable material, like z. B. Ni or CuNi, exist, in order to be able to manufacture the pot form problem-free. Also the tab of the second terminal electrode can become with such a material in simple manner bent upward.

[0048] To the seal the converter chamber can exhibit a freeing, into some O ring (z. B. from elastomer) laid is. In a special embodiment the O ring can be provided in the corner area between bar and adjacent surface of the converter chamber.

[0049] The diaphragm can at least partly along-lead between the O ring and the adjacent surface of the converter chamber. The diaphragm exhibits therefore thus a circumferential rim. This connection has the advantage that a constant fixation of the swinging element and/or a constant sound bridge or Schallisolation between converter chambers and swinging member ensured become. On the bar and/or the adjacent surface of the converter chamber an additional adhesive or a double sided adhesive tape can become applied, which strengthens the connection additional.

[0050] The diaphragm can exhibit breakthroughs, into the pins of the converter chamber engage, whereby the breakthroughs and the pins are welded with one another. This leads to a particularly intimate connection of diaphragm and converter chamber.

[0051] Additional one can be the diaphragm around the edge of the adjacent surface guided. The diaphragm is thus first guided along the bar, the adjacent surface and finally the edge of the adjacent surface. The sequence is an other increasing the strength of the connection as well as the tightness. In addition thereby the fixation of the diaphragm can become possibly defined adjusted.

[0052] So that the components can exhibit the converter chamber as well as the diaphragm corresponding slopes with the assembly light collapse (throw fit), can.

[0053] The invention of claim 21 plans that the managing support in the converter chamber, on that the piezoelectric disc with its back and/or. the second electrode in axial direction more rigid rests upon, over the whole area of the back of the piezoelectric disc formed full-laminar essentially is. In this construction also smaller ultrasonic transducers exhibit a higher compressive strength. The piezoelectric disc cannot break through also with pressurization. In addition the quality of the ultrasonic transducer can become affected by the choice of the thickness of the support, by unwanted responses eliminated to become to be able. By the flatness of the support the quality and power of the ultrasonic transducer do not change.

[0054] Additional one can be stuck the piezoelectric disc on their back with the terminal electrode, which leads to an other improvement of the quality. Unevenness can become thereby balanced and the oscillation thing remains stable.

[0055] Natural one can contain this ultrasonic transducer according to invention also all favourable execution variants, which became already above explained.

[0056] Furthermore according to invention it is stressed that several piezoelectric discs can be provided within an ultrasonic transducer, whereby a diaphragm at least two piezoelectric discs contacted. A diaphragm spans therefore thus several piezoelectric discs. Z. B. this is favourable with different aerofoils. The piezoelectric discs can be both one behind the other and laminar arranged. The piezoelectric discs as well as the diaphragm can thereby in and/or. at a common converter chamber arranged its.

[0057] The invention is more near explained on the basis advantageous embodiments on the basis the drawing figures. These show:

Fig. 1 a principle representation of an ultrasonic transducer in the section;
Fig. 2 a plan view on the ultrasonic transducer in accordance with Fig. 1;
Fig. 3 a principle representation of an ultrasonic transducer in an alternative embodiment compared with Fig. 1 in the section.
Fig. 4 a perspective view of the ultrasonic transducer in accordance with Fig. 3;
Fig. 5 a perspective view of the ultrasonic transducer in accordance with Fig. 3 and/or. 4, partial cut;
Fig. 6 a cutout of the ultrasonic transducer in the section;
Fig. 7 a sectional view of the ultrasonic transducer in accordance with Fig. 5;
Fig. 8 a possibility of the arrangement of the ultrasonic transducers in a flowmeter;
Fig. 9 a Nebeneinanderanordnung of the ultrasonic transducers with separate converter chambers and diaphragm;
Fig. 10 a Nebeneinanderanordnung of the ultrasonic transducers with common converter chambers and diaphragm;
Fig. 11 a perspective view of an alternative execution variant of an ultrasonic transducer;
Fig. 12 a sectional view of the ultrasonic transducer in accordance with fig 11, somewhat modified;
Fig. 13 a sectional view of the ultrasonic transducer in accordance with fig 11 as well as
Fig. 14 an isometric bottom view of an ultrasonic transducer.

[0058] Reference numeral 1 the referred ultrasonic transducer in its entirety. The ultrasonic transducer 1 is in particular designed for the use in a flowmeter for liquid or gaseous medium. It exhibits a piezoelectric disc 2, which is in a topfförmigen converter chamber 3 22 arranged with open side and is at of them the Mediums directed front side 4 a first electrode 6 as well as at their back 5 a second electrode 7 arranged. Furthermore the first electrode 6 with a first terminal electrode and the second electrode are 7 contacted with a second terminal electrode 9 to the power supply. The power cable for the power supply is provided with reference numeral 21. The first terminal electrode is additional as diaphragm 8 formed and to the converter chamber 3 provided. The diaphragm 8 locks the open side 22 of the topfförmigen converter chamber 3. By means of this construction the piezoelectric disc is 2 safe and stable in the receptacle 10 held. With the piezoelectric disc 2 it concerns a thick

resonance oscillator. In order to suppress apart from the desired thick oscillation unwanted or parasitic modes of motion such as radial or diagonal oscillations, simultaneous are struck by the construction provisions, which suppress these modes of motion.

[0059] The diaphragm 8 stands more immediate with the Mediums which can be measured in contact, like z. B. from Fig. 9 comes out.

[0060] The diaphragm 8 is likewise topfförmig formed like the converter chamber 3 and with the converter chamber 3 so assembled that the receptacle becomes 10 formed. This embodiment of the ultrasonic transducer a permitted high degree of automation with its fabrication.

[0061] The piezoelectric disc 2 rests upon a managing support 16 of the converter chamber 3. The support 16 is in Fig. 1 annular formed. In the other figs the support is 16 laminar formed. The piezoelectric disc 2 rests upon therefore in an axial direction stable and can swing toward diaphragm forward as well as radial free. In addition the piezoelectric disc 2 rests upon from the diaphragm 8 fixed the support 16. The support 16 is integral part of the converter chamber 3.

[0062] The diaphragm 8 exhibits a peripheral edge 12, which rests against a circumferential bar 11 of the converter chamber 3 outer. The peripheral edge 12 of the diaphragm 8 can enclose the circumferential bar 11 positive. This connection can do additional by means of an adhesive layer between edge 12 and bar 11 secured and/or. sealed become.

[0063] The diameter of the support 16 is at least as large as the diameter of the piezoelectric disc 2, in order to ensure a stable support of the disc 2.

[0064] The second terminal electrode 9 is with the piezoelectric disc 2 and/or. the second electrode 7 bonded. On the other hand the second terminal electrode is 9 also 16 bonded with the support, to which a double sided adhesive tape used will, in order to guarantee a constant gap and thus an optimum measuring behavior.

[0065] Likewise also the diaphragm is 8 with the piezoelectric disc 2 and/or. the first electrode 6 bonded.

[0066] The first as well as second terminal electrode 8, 9 exhibit in each case one upward toward an electrical terminal distant tab 14, 15. These tabs 14, 15 serve simultaneous - at least with the diaphragm 8 - as extension of the topfförmigen edge 12 and form contact tongues to the connection (z. B. Connector) with the power cable 21.

[0067] The tabs 14, 15 of the first as well as second terminal electrodes 8, 9 step by openings 18 of the converter chamber 3 outward and are in the openings 18 and thus simultaneous sealed by means of a suitable adhesive without strain. The explanation of the strain relief of the tabs 14, 15 becomes on the figs 5 - 7 respect taken. The tab 15 of the second terminal electrode 9 and/or. a projection 26 of the tab 15 supports itself against a stage 23 of the converter chamber 3 off. The stage 23 is at a column 25 of the converter chamber 3 provided. By this support a strain relief of the tab becomes 15 achieved (see. to the support of the tab 15 Fig. 5 and 6).

[0068] The diaphragm 8 against it supports itself in a channel 24 of the converter chamber 3 off (see figs 5 and 7). In particular a rim is 27 provided, in the channel the 24 in-lies at the diaphragm 8.

[0069] The piezoelectric disc 2 becomes fixed of the diaphragm 8 in their position and rests upon nevertheless without bias on the support 16, so that it can train an optimum swinging behavior.

[0070] The space 17 formed by the managing support 16 and the diaphragm 8 is in Fig. 1 and thus almost ultrasonic-insulative filled with air. The piezoelectric disc 2 is of the bar 11 of the converter chamber 3 and/or. the edge 12 of the diaphragm 8 spaced, so that the piezoelectric disc can swing radial free. In addition a photograph reservoir for excess adhesive or adhesive burrs becomes formed by this distance, which therefore does not impair rockers of the disc. The adhesive is 16 mounted thereby to the attachment of the piezoelectric disc 2 with the support or also at other connections of the components provided.

[0071] The support 16 and/or. it consists the converter chamber 3 also with the full surface support 16 of PVDF which has the advantage that it is adapted with many parameters, in particular with the impedance that of the water. This is natural from advantage only if it concerns with the Mediums which can be measured also waters.

[0072] In order to arrange the assembly still more effective, the second terminal electrode can become 9 also by a metallic coating formed.

[0073] The diameter of the piezoelectric disc 2 amounts to at the most 7.5 mm. The diameter of the piezoelectric disc 2 is 3.3 to 3.8 times large thickness designed as of them for 1 MHZ. By means of the small diameter of the piezoelectric disc an high compressive strength becomes provided. In addition the resonant frequency of 1 MHZ becomes achieved with these dimensions.

[0074] The diaphragm 8 the effected long-term and temperature-stable fixation piezoelectric disc 2 and ensured measurements with very small offset, constant thereby over a long time.

[0075] In the corner area between bar 11 and adjacent surface 13 of the converter chamber 3 is an O ring 19 provided, which provides for a seal of the diaphragm 8.

[0076] For a long-term-stable connection the converter chamber 1 can and/or. the bar 11 or the surface 13 a groove exhibits, into which the diaphragm 8 dives. This groove can be by melts of a circumferential nose of the converter chamber 3 additional with adhesive filled, so that the ultrasonic transducer is 1 watertight.

[0077] Converter chamber 3 and diaphragm 8 can exhibit corresponding slopes, so that the parts can collapse with the assembly light.

[0078] In Fig. a converter chamber 3 with a support 16 exhibits 7 represented ultrasonic transducers, which is full-laminar essentially 2 formed over the whole area of the back 5 of the piezoelectric disc. The second terminal electrode 9 stuck on the support 16 is, with which an improvement of the quality becomes achieved, remains the oscillation thing stable and unevenness balanced becomes. The full surface formation of the support 16 leads to the fact that the piezoelectric disc 2 always planar rests upon and the measuring quality of the transducer constant remains. The thickness of the support 16 (so called absorber-high) amounts to 3.55 mm. Fig. a possible arrangement of the two ultrasonic transducers 1 shows 8, whereby the flow direction of the

Mediums is characterized by means of the arrows.

[0079] In Fig. 9 is a part of a flowmeter shown, with which likewise two ultrasonic transducers are 1 next to each other arranged. Each ultrasonic transducer 1 exhibits thereby a separate converter chamber 3 as well as a diaphragm 8 in each case. The diaphragm 8 fixed in each case a piezoelectric disc 2. The sound path runs transverse to the water path. So that the taking along effect occurs, the sound must become by means of mirrors diverted. The mirrors for sound detour did not become however shown.

[0080] In Fig. 10 is an ultrasonic transducer 1 shown, is arranged with which two piezoelectric discs 2 in a common converter chamber 3. In addition the two piezoelectric discs 2 become 8 contacted of a common diaphragm. The technical advantages with this arrangement consist of the fact that fewer parts required become, will a simpler terminal possible and become a smaller construction due to the shorter distance of the two piezoelectric discs 2 to each other possible.

[0081] 13 ultrasonic transducers represented in the figs 11, the 12 and no topfförmiges converter chamber in the sense of the figs 1 to 10 exhibits 1 contrary to the previous ultrasonic transducers. With the ultrasonic transducer in accordance with the figs 11, 12 and 13 the first terminal electrode is likewise additional as diaphragm 8 formed and to the converter chamber 3 provided, whereby the diaphragm 8 locks the converter chamber 3. Also in these execution variants the piezoelectric disc 2 safe is held by the topfförmige diaphragm 8 at the converter chamber 3. The diaphragm 8 stands also more immediate with the Mediums which can be measured in contact. In addition the diaphragm 8 exhibits a rim 27, in-convenient in the figs 11 and 13 in a channel 24 of the converter chamber 3. In fig 12 against it the upper part of the edge 12 of the diaphragm 8 as well as the circumferential rim 27 cast in by means of a potting compound 29 are into a circumferential recess of the converter chamber 3.

[0082] In addition the peripheral edge 12 of the diaphragm 8 runs to a circumferential bar 11 of the converter chamber 3 bottom formation of a gap 28. The gap 28 provides for a decoupling of diaphragm 8 and converter chamber 3, so that these elements expand with temperature variations as unobstructed ones as possible and/or. to pull together can.

[0083] In fig a full surface support 16 for the piezoelectric disc shows 14 represented converter chambers 3. On the support 16 guide pins are 30 arranged, on which the second terminal electrode 9 borders and becomes in this way in its layer fixed. The second terminal electrode 9 is however in fig 14 not shown.

REFERENCE SYMBOL LIST

1 Ultrasonic transducer
2 piezoelectric disc
3 Converter chamber
4 Front side
5 Back
6 first electrode
7 second electrode
8 first terminal electrode (diaphragm)
9 second terminal electrode
10 Receptacle
11 Bar
12 Edge
13 Surface
14 Tab
15 Tab
16 Support
17 Space
18 Openings
19 O ring
20 Edge
21 Power cable
22 open side
23 Stage
24 Channel
25 Column
26 Projection
27 Rim

28 Gap
29 Potting compound
30 Guide pin